DOE/ID-12082(03)

ISSN 1089-5469
STOLLER-ESER-74

Idaho National Engineering and Environmental Laboratory Site Environmental Report Calendar Year 2003

Environmental Surveillance, Education and Research Program

U.S. Department of Energy Idaho Operations Office

October 2004

S. M. Stoller Corp.

This report was prepared for the
U.S. Department of Energy Idaho Operations Office
Under Contract DE-AC07-00ID13658
By the S. M. Stoller Corporation
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Idaho National Engineering and Environmental Laboratory's Environmental Policy

It is the policy of the U.S. Department of Energy (DOE) to conduct research, environmental remediation, and operations at the Idaho National Engineering and Environmental Laboratory (INEEL) in a manner that protects human health and the environment and is in full compliance with environmental laws and regulations.

The INEEL achieves this by integrating environmental requirements and pollution prevention into all work planning and execution, and by taking actions to minimize the environmental impacts of operations. Through employee involvement and management commitment to environmental excellence, the INEEL will:

- Protect the unique natural, biological, and cultural resources of the INEEL.
- Conduct operations and manage hazardous and radioactive materials and wastes in a safe, compliant, and cost-effective manner. This is done by establishing and communicating environmental responsibilities, by providing environmental training to the workforce, and by implementing controls to mitigate environmental hazards.
- Conduct environmental remediation to address contamination from legacy activities and minimize impacts on human health and the environment.
- Develop and deploy new and enhanced environmental technologies and share this expertise with other DOE sites, the local community, and external customers.
- Integrate pollution prevention into project planning, design, and construction to minimize toxicity and volume of waste generated; conserve natural resources and energy; and minimize environmental impacts.
- Conserve natural resources by reusing and recycling materials, purchasing recycled materials, and using recyclable materials.
- Promptly identify noncompliant conditions and encourage full disclosure and open discussion regarding compliance issues. Aggressively work to resolve identified issues.
- Establish documented environmental objectives and milestones, and update them as necessary to reflect the changing needs, missions, and goals of the INEEL.
- Consider the input of stakeholders when weighing options.
- Measure environmental performance and monitor impacts on the environment, and communicate the results to employees and stakeholders.
- Continuously improve the INEEL environmental management system through self assessment and corrective action.

This policy applies to all business units and all employees. Every employee and subcontractor is expected to follow this policy and to report environmental concerns to management. Managers shall promote environmental stewardship, take prompt action to address concerns and issues, and have zero tolerance for noncompliance.

INEEL
Idaho National Engineering and Environmental Laboratory
BECHTEL BWXT IDAHO, LLC

Acknowledgments

The following people with the current Environmental Surveillance, Education and Research (ESER) contractor (S. M. Stoller Corporation) have provided primary authorship of portions of this report: Marilyn Case, Christopher Martin, Roger Blew, Douglas Halford, and Randall Morris[1].

The primary authors would like to thank all those who provided data and review time for the completion of this document. In particular, we wish to thank the following people for their assistance: Mark Arenaz, Jack Depperschmidt, Bob Jones, Betsy Jonker, Richard Kauffman, John Medema, Don Rasch, Tim Safford, Bob Starck, Bob Stump, Jerry Wells, Stephanie Woolf, Patricia Natoni, Brian Edgerton, Frank C. Holmes, Shannon Brennan, Keith Lockie, Teresa Perkins, Brett Howhan, Dave Wessman, Jim Cooper, and Ron Ramsey with the U.S. Department of Energy (DOE) Idaho Operations Office; Leroy Knobel and Betty Tucker with the U.S. Geological Survey; W. Greg Bass with the DOE Chicago Operations Office Argonne Area Office; Neil Hukari and Richard Eckman of the National Oceanic and Atmospheric Administration; Wendy Dixon of the DOE Pittsburgh Naval Reactors Office, Idaho Branch Office; Erik Fowler, Mark Hutchinson, Paula Kain, Marty Nolte, Bruce Olenick, and Kelly Willie of Bechtel Bettis Inc.; Brad Andersen, Ben Beus, Bryan Borsella, Teresa Brock, John Gill, Mike Lewis, Dennis McBride, Teresa Meachum, Maria Miles, Joan Neff, Erick Neher, Paul Ritter, Ron Rope, Chris Staley, Angela Stormberg, Leah Street, Amy Sumariwalla, Jim Tkachyk, Mike Verdoorn, Roger Wilhelmsen, Cheryl Whitaker, and Tom Wood with Bechtel BWXT Idaho, LLC; Amy Powell, Maureen Finnerty, and Tim Miller of Argonne National Laboratory-West; Christopher Jenkins, Denim Jochimsen, Terence McGonigle, Nanacy Glenn, Valerie Sheedy with the Idaho State University; Robert Westra with the Washington State University; Mike Pellant with the Idaho State Office of the Bureau of Land Management; Amy Forman, Wendy Purrington, Alana Jensen, and Brande Hendricks of the S. M. Stoller Corporation; Jeff Einerson (statistician); Matt Klainer and Greg Forrer (technical editors).

[1] Randall Morris is with North Wind, Inc.

Preface

M. Case and C. Martin - S. M. Stoller Corporation

Every person in the world is exposed to ionizing radiation, which may have sufficient energy to remove electrons from atoms, damage chromosomes, and cause cancer. There are three general sources of ionizing radiation: those of natural origin unaffected by human activities, those of natural origin but enhanced by human activities, and those produced by human activities (anthropogenic).

The first general source includes terrestrial radiation from natural radiation sources in the ground, cosmic radiation from outer space, and radiation from radionuclides naturally present in the body. Exposures to natural sources may vary depending on the geographical location and altitude at which the person resides. When such exposures are substantially higher than the average, they are considered to be elevated.

The second general source includes a variety of natural sources from which the radiation has been increased by human actions. For example, radon is a radioactive gas which is heavier than air. It comes from the natural decay of uranium and is found in nearly all soils. Concentrations of radon inside buildings may be elevated because of the type of soil and rock upon which they are built (high in uranium or radon) and may be enhanced by cracks and other holes in the foundation (providing access routes for the gas). Another example is the increased exposure to cosmic radiation that airline passengers receive when traveling at normal cruising altitudes. The third source includes a variety of exposures from human-made materials and devices such as medical x-rays, radiopharmaceuticals used to diagnose and treat disease, and consumer products containing minute quantities of radioactive materials (UNSCEAR 2000).

To verify that exposures resulting from operations at U.S. Department of Energy (DOE) nuclear facilities remain very small, each site where nuclear activities are conducted operates an environmental surveillance program to monitor the air, water, and other pathways whereby radionuclides from operations might conceivably reach workers and members of the public. Environmental surveillance and monitoring results are reported annually to DOE Headquarters.

This report presents a compilation of data collected in 2003 for the environmental monitoring and surveillance programs conducted on and around the Idaho National Engineering and Environmental Laboratory (INEEL). During 2003, the Environmental Surveillance, Education and Research (ESER) Program was performed by a team led by the S. M. Stoller Corporation. This team collected 2003 data and prepared this report. During 2003, the INEEL was operated by Bechtel BWXT Idaho, LLC (BBWI). This report refers to BBWI as the Management and Operating (M&O) contractor. The M&O organization responsible for operating each facility conducted effluent and facility monitoring. The U.S. Geological Survey performed groundwater monitoring both on and off site. The M&O contractor also conducted some onsite groundwater monitoring related to waste management, clean-up/restoration, and environmental surveillance. The National Oceanic and Atmospheric Administration collected meteorological data.

This report also contains information on nonradiological monitoring performed during the year. Results of this monitoring, both chemical (liquid effluent constituent concentrations) and physical (particulates) are presented. Nonradiological parameters monitored are those required under permit conditions or are related to material released from INEEL operations.

Argonne National Laboratory-West (ANL-W), the Naval Reactors Facility (NRF) and the Advance Mixed Waste Treatment Project (AMWTP) maintain separate monitoring programs. Each program collects similar data as the M&O and ESER contractors, but the data are specific to these facilities. ANL-W provides its information to the ESER contractor for incorporation into this annual report. AMWTP performs limited monitoring as a best management practice, and is not presented in this report. The M&O Environmental Monitoring Unit performs all regulatory and surveillance monitoring at this facility, which is presented here. The INEEL Oversight Program, under the Idaho Department of Environmental Quality, maintained independent sample locations and analysis capabilities both on and around the INEEL in 2003.

Facilities operated under the Naval Nuclear Propulsion Program, like the NRF, are exempt from the provisions for preparing an annual site environmental report. The Naval Nuclear Propulsion Program maintains a separate environmental protection program to ensure compliance with all applicable environmental laws and regulations. Monitoring data and information specific to NRF are provided in a separate annual environmental report issued by NRF. For completeness, data from onsite monitoring programs at NRF are referenced in this report.

This report, prepared in accordance with the requirements in DOE Order 450.1 and 231.1, is not intended to cover the numerous special environmental research programs conducted at the INEEL (DOE 2003a, 2003b).

REFERENCES

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), 2000, “Sources and Effects of Ionizing Radiation,” Vol. 1, UNSCEAR 2000 Report to the General Assembly with Scientific Annexes.

U.S. Department of Energy, 2003a, "Environmental Protection Program," DOE Order 450.1, January.

U.S. Department of Energy, 2003b, "Environment, Safety, and Health Reporting," DOE Order 231.1, August.

Executive Summary

M. Case - S. M. Stoller Corporation

Each year the U.S. Department of Energy (DOE) publishes the Idaho National Engineering and Environmental Laboratory (INEEL) site environmental report to summarize environmental data, information, and regulations, and highlight major environmental programs and efforts. In summary, the results of the monitoring programs for 2003 presented in this report indicate that radioactivity from current INEEL operations could not be distinguished from worldwide fallout and natural radioactivity in the region surrounding the INEEL. Radioactive material concentrations in the offsite environment were below State of Idaho and federal health protection guidelines. Potential doses to the maximally exposed individual and to the surrounding population were estimated to be well below the applicable regulatory limit and far less than doses resulting from background radiation.

Organization of the Report

Individual chapters of the report are designed to:

- Provide an overview of the INEEL site, mission, and history (*Chapter 1*);
- Summarize the status of INEEL compliance with environmental regulations (*Chapter 2*);
- Describe major activities and milestones in environmental restoration, waste management, and other environmental programs, and review INEEL environmental surveillance programs (*Chapter 3*);
- Present and evaluate results of environmental monitoring of air (*Chapter 4*);
- Present and evaluate results of monitoring of liquid effluent, drinking water, and storm water for compliance with applicable laws, regulations, and other requirements (*Chapter 5*);
- Present and evaluate results of environmental monitoring of groundwater and surface water (*Chapter 6*);
- Present and evaluate results of environmental monitoring of other media (*Chapter 7)*
- Discuss the potential radiation dose to the public and to biota (*Chapter 8*);
- Describe ecological research activities that took place on the INEEL (*Chapter 9*); and
- Discuss programs used to ensure environmental data quality (*Chapter 10*).

Chapter highlights are presented below.

Introduction (Chapter 1)

The Atomic Energy Commission created what is now the INEEL as the National Reactor Testing Station in 1949 as a site to build and test nuclear power reactors. The INEEL occupies approximately 2300 km^2 (890 mi^2) of the upper Snake River Plain in southeastern Idaho. Over the life of the INEEL, 52 types of reactors, associated research centers, and waste handling areas have been constructed and tested.

The INEEL serves as a multi-program national laboratory that delivers science and engineering solutions to the world's environmental, energy, and security challenges in four core areas:

- Science-based, engineered solutions to challenges of the DOE's mission areas, other federal agencies, and industrial clients.
- Completion of environmental cleanup at the INEEL.
- Enhancement of scientific and technical talent, facilities, and equipment to best serve national and regional interests.
- Leadership and support to the Environmental Management mission throughout the DOE complex.

There are nine primary facility areas and three smaller secondary facilities at the INEEL and in Idaho Falls. Six of the nine primary facilities and the three secondary facilities are operated by the INEEL Management and Operating (M&O) Contractor Bechtel BWXT Idaho, LLC. The University of Chicago, British Nuclear Fuels Limited, Inc., and Bechtel Bettis, Inc. operate the remaining three primary facilities at the INEEL.

Approximately 7000 people work at the INEEL, making it the largest employer in eastern Idaho and one of the top five employers in the State. The INEEL has a tremendous economic impact on eastern Idaho. The INEEL has infused more than $750 million dollars to the Idaho economy.

Environmental Compliance Summary (Chapter 2)

Table ES-1 presents a brief summary of the INEEL's status of compliance with federal acts in 2003.

Environmental Program Information (Chapter 3)

Many environmental programs help implement the environmental compliance policy for the INEEL. Most of the regulatory compliance activity is performed through environmental monitoring programs, the recently signed Accelerated Cleanup Agreement, the Environmental Restoration Program, and the Waste Management Program.

Table ES-1. Compliance with federal acts in 2003.

Act	What it Addresses	2003 Activities
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	This act provides specific procedures to assess and remediate areas where the release or potential of a release of hazardous substances has occurred.	The INEEL continues to make progress on remedial actions in compliance with CERCLA requirements. By the end of 2003 more than 70% of CERCLA actions are complete. The Agency for Toxic Substances and Disease Registry (ATSDR) released the draft public health assessment of the INEEL, as required by CERCLA, for public review and comment.
Resource Conservation and Recovery Act (RCRA)	This act establishes regulatory standards for the generation, transportation, storage, treatment, and disposal of hazardous waste.	The Idaho Department of Environmental Quality (DEQ) conducted a RCRA inspection at the INEEL in August 2003. Two notices of violation (NOVs) were issued as a result. A Consent Order to resolve the NOVs was negotiated by the State of Idaho, Bechtel BWXT Idaho LLC, the DOE Idaho Operations Office and British Nuclear Fuels Limited, Inc. and the alleged violations were resolved. The State of Idaho approved RCRA closure plans for three facilities at the INEEL.
Federal Facility Compliance Act	This act requires the preparation of site treatment plans for the management of mixed wastes stored or generated at DOE facilities.	Five site treatment plan milestones were met in 2003.
Clean Air Act	This act sets the standards for ambient air quality and for emission of hazardous air pollutants.	Compliance with the Idaho air quality program was primarily administered through the permitting process. The 2003 National Emission Standards for Hazardous Air Pollutants report documented a maximum annual individual dose to a member of the public from INEEL releases of 0.035 mrem/yr, well below the regulatory limit of 10 mrem/yr.
Clean Water Act	This act establishes goals to control pollutants discharged to surface waters of the United States.	EPA Region 10 issued a letter in October 2003 with the determination that INTEC, RWMC, and TAN do not have a reasonable potential for discharge to waters of the U.S. DOE-ID directed the M&O to cease stormwater activities at those facilities in December 2003.
Safe Drinking Water Act	This act establishes primary and secondary standards for drinking water systems.	No U.S. Environmental Protection Agency health-based drinking water regulatory limits were exceeded in 2003.
Toxic Substances Control Act	This act regulates industrial chemicals currently produced or imported into the United States.	The INEEL was in compliance with management of polychlorinated biphenyls in 2003.
National Environmental Policy Act	This act requires federal agencies to consider and evaluate potential environmental impacts as a result of federal activities and requires the study of alternatives to mitigate those impacts.	The final Environmental Assessment to evaluate pre-fire planning, fire response, and post-fire restoration alternatives was issued in 2003, with a finding of no significant impact.
Emergency Planning and Community Right-to-Know Act (EPCRA)	This act provides the public with information about hazardous chemicals and establishes emergency planning and notification procedures to protect the public from chemical releases.	The EPCRA Section 311 and 312 Reports were issued as required in 2003. The Toxic Chemical Release Inventory Report (313) was issued for eight chemicals used on the INEEL.

The major objectives of the environmental monitoring programs conducted at the INEEL are to identify the key contaminants released to the environment, to evaluate different pathways through which contaminants move in the environment, and to determine the potential effects of these contaminants on the public and the environment. This is accomplished though sampling and analysis of air; surface, subsurface, and drinking water; soil; wildlife; and vegetation, as well as measurement of direct radiation. During 2003, the prime Management and Operating (M&O) contractor at the INEEL, Bechtel BWXT Idaho, LLC was responsible for onsite environmental monitoring. The Environmental Surveillance, Education and Research Program (ESER) contractor, which was a team led by the S. M. Stoller Corporation, was responsible for offsite environmental monitoring.

In May 2002, DOE, the Idaho Department of Environmental Quality and the U.S. Environmental Protection Agency signed a letter of intent formalizing an agreement to pursue accelerated risk reduction and cleanup at the INEEL. The intent of accelerating the cleanup of the INEEL yields two significant objectives: (1) risk reduction and continued protection of the Snake River Plain Aquifer and (2) consolidation of Environmental Management activities and reinvestment of savings into cleanup. Nine strategic initiatives were developed around these two objectives to accelerate cleanup. The INEEL made significant progress in 2003 toward accelerated cleanup.

The Environmental Restoration Program continued progress during 2003 toward final cleanup of contaminated sites at the INEEL. Since the Federal Facility Agreement and Consent Order was signed in December 1991, 22 Records of Decision (ROD) have been signed and are being implemented; three Remedial Investigation/Feasibility Studies are under development; closeout activities at Waste Area Group 2 have been completed, and more than 70 percent of Comprehensive Environmental Response, Compensation, and Liability Act actions have been completed. Only three investigations remain to be completed:

- Buried waste at the RWMC Waste Area Group-7 (WAG 7);
- Soil contamination at the INTEC Tank Farm (WAG 3, Operable Unit [OU] 3-14;
- Snake River Plain Aquifer contamination (WAG 10, Operable Unit 10-8)

All requirements have been met and all Federal Facility Agreement and Consent Order-enforceable milestones related to the WAG 2 ROD have been completed. This is the first WAG at the INEEL be closed out and prepared for transition into Long-Term Stewardship management.

The overall goals of the Waste Management Program are to ensure that workers and the public are protected and the environment is not further impacted by waste operations at the INEEL. The Waste Management Program provides management services for facility waste streams. The following tasks were accomplished during 2003:

- Five Site Treatment Plan milestones were met.
- British Nuclear Fuels Limited, Inc. commenced retrieval operations at the Advanced Mixed Waste Treatment facility in March 2003.

- Over 900 m^3 (1177 yd^3) of mixed low-level waste was treated and disposed of in 2003.
- The Transuranic Waste Program shipped 384 m^3 (502 yd^3) of transuranic waste to the Waste Isolation Pilot Plant in Carlsbad, New Mexico.
- The INEEL accelerated efforts to decontaminate, decommission, and demolish aging, unnecessary buildings and structures. Over 5574 m^2 (60,000 ft^2) of buildings and structures were demolished in 2003.

Environmental Monitoring Programs - Air (Chapter 4)

The INEEL environmental surveillance programs, conducted by the M&O contractor and the ESER contractor, emphasize measurement of airborne radionuclides because air transport is considered the major potential pathway from INEEL releases to receptors. The M&O contractor monitors airborne effluents at individual INEEL facilities and ambient air outside the facilities to comply with appropriate regulations and DOE orders. The ESER contractor samples ambient air at locations within, around, and distant from the INEEL.

An estimated total of 7796 Ci of radioactivity, primarily in the form of short-lived noble gas isotopes, was released as airborne effluents in 2003. Samples of airborne particulates, atmospheric moisture, and precipitation were analyzed for gross alpha and gross beta activity, as well as for specific radionuclides, primarily tritium, strontium-90, iodine-131, cesium-137, plutonium-239/240, and americium-241. All concentrations were well below regulatory standards and within historical measurements. Table ES-2 summarizes the results of radiological monitoring of environmental media, including air, sampled at INEEL boundary, onsite, and offsite locations.

Nonradiological pollutants, including nitrogen dioxide and particulates, were monitored at select locations around the INEEL. All results were well below regulatory standards.

Environmental Monitoring Programs - Water (Chapter 5)

One potential pathway for exposure (primarily to workers) to the contaminants released from the INEEL is through surface, drinking, and groundwater. The M&O contractor monitors liquid effluents, drinking water, groundwater, and storm water runoff at the INEEL to comply with applicable laws and regulations, DOE orders, and other requirements (e.g., Wastewater Land Application Permit [WLAP] requirements). Argonne National Laboratory-West and the Naval Reactors Facility conduct their own WLAP and drinking water monitoring. The ESER contractor monitors drinking water and surface water at offsite locations.

During 2003, liquid effluent and groundwater monitoring was conducted in support of WLAP requirements for INEEL facilities that generate liquid waste streams covered under WLAP rules. The WLAPs generally require compliance with the Idaho groundwater quality primary and secondary constituent standards in specified groundwater monitoring wells. The permits specify annual discharge volume and application rates and effluent quality limits. As required, an annual report was prepared and submitted to the Idaho Department of Environmental Quality. Additional parameters are also monitored in the effluent in support of surveillance activities. Most

Table ES-2. Boundary, onsite, and offsite radiological environmental monitoring results for 2003 (data from Chapters 4, 5, 6, and 7).

Media	Sample Type	Analysis	Results
Air	Charcoal cartridge	Radioiodine	Iodine-131 (^{131}I) was not detected in any individual charcoal cartridge collected.
	Particulate filter	Gross alpha and gross beta activity, gamma-emitting radionuclides, strontium-90 (^{90}Sr), and americium-241, plutonium 238, 239/240	In general, gross alpha and gross beta activities show levels and seasonal variations not attributable to INEEL releases. Five of the weekly gross beta results showed statistical differences between boundary and distant locations. In all cases the differences were attributed to natural variation or to inversion conditions. All measurements of specific radionuclides were well below Derived Concentration Guide (DCG) for radiation protection and within historical results.
	Atmospheric moisture	Tritium	Tritium was detected in 13 of 44 samples. Measurements were well below the DCG and within historical concentrations.
	Precipitation	Tritium	Tritium was detected in 13 of 53 precipitation samples. Measurements were well below the DCG and within historical measurements made at the INEEL and within U.S. Environmental Protection Agency (EPA) Region 10 (ID, OR, WA, and AK) historical levels.
Water	Surface water	Gross alpha and gross beta activity, and tritium	Gross alpha activity was detected in one sample. Nine of 12 samples had measurable gross beta activity. All were below the EPA screening level. Tritium was detected in one sample. The highest level measured was below the EPA Maximum Contaminant Level (MCL).
	Drinking water	Gross alpha and gross beta activity, and tritium	No EPA health-based drinking water or DOE regulatory limits were exceeded in 2003.
Agricultural products	Milk, lettuce, wheat, potatoes, and sheep	Gamma-emitting radionuclides and ^{90}Sr	Some human-made radionuclides were detected in agricultural samples. All concentrations were similar to historical measurements and appear to be attributable to past weapons testing fallout.
Game animals	Ducks, mule deer, elk, and pronghorn	Gamma-emitting radionuclides, ^{90}Sr and specific actinides. Iodine-131 in deer, elk, and pronghorn thyroids	Cesium-137 was detected in some muscle, thyroid, or liver samples of mule deer and pronghorn at levels consistent with past weapons testing fallout. Low levels of ^{137}Cs and ^{90}Sr were found in five marmots. Levels were below those from previous investigations. One or more human-made radionuclides were detected in at least one tissue type in 11 waterfowl collected from INEEL wastewater ponds and control areas. The potential dose from consumption of waterfowl with the highest concentrations was calculated to be 0.002 mrem (0.001 percent of 363 mrem from background sources).
Soil	Offsite soil composite samples	Gamma-emitting radionuclides, ^{90}Sr and the same actinides analyzed in particulate filters	Soil sampling was not conducted by the ESER contractor in 2002. Radionuclide levels in soils at 186 site surveillance locations near major INEEL facilities were measured by the M&O contractor using in situ gamma spectrometry. The results show concentrations above background at ARA and INTEC, but consistent with historical concentrations at these locations. Measurements at ANL-W, NRF, and the Large Grid were within background levels. The concentrations are most likely due to weapons testing fallout.
Radiation exposure	Thermoluminescent dosimeters	Gamma radiation	Exposures at boundary and distant locations using environmental dosimeters were similar and showed levels consistent with previous years' measurements and with background levels.

wastewater and groundwater regulatory and surveillance results were below applicable limits in 2003.

Samples from public water systems and wells continue to show measurable quantities of carbon tetrachloride at the Radioactive Waste Management Complex production well. The annual average of 2.8 μg/L was below the U.S. Environmental Protection Agency (EPA) established maximum contaminant level (MCL) of 5 μg/L. Trichloroethylene concentrations in samples from the Test Area North drinking water system during 2003 also remained below the MCL. Argonne National Laboratory-West and Naval Reactors Facility systems did not exceed any limits during 2003.

Tritium and strontium-90 continue to be measured in the groundwater under the INEEL. Neither of these radionuclides has been detected off the INEEL since the mid-1980s. A maximum effective dose equivalent of 0.88 mrem/yr (8.8 μSv/yr), less than the 4 mrem/yr 40 μSv/yr) EPA standard for public drinking water systems, was calculated for workers at the Central Facilities Area on the INEEL in 2003.

Drinking water samples were collected from 13 locations off the INEEL and around the Snake River Plain in 2003. No sample had measurable gross alpha, one had measurable tritium, and most samples (19 of 28) had measurable gross beta activity. None of the samples exceeded the EPA MCL for these constituents.

As required by the General Permit for storm water discharges from industrial activities, visual examinations were made and samples were collected from selected locations. Visual examinations showed no deficiencies. Total suspended solids, iron, and magnesium all exceeded benchmark levels in samples collected from the RWMC. Concentrations of these parameters have occurred above benchmark levels in the past. Examination of storm water flow paths showed no deficiencies in storm water protection.

Environmental Monitoring Program - Groundwater and Surface Water (Chapter 6)

Results from nine special studies conducted by the U.S. Geological Survey of the properties of the aquifer were published during 2003. Several purgeable organic compounds continue to be found in monitoring wells, including drinking water wells at the INEEL. Concentrations of organic compounds were below the State of Idaho groundwater primary and secondary constituent standards as well as EPA MCLs for these compounds. (Note: the MCL is used for comparison only as the MCL applies only to the distribution system and not the source well).

Offsite surface water was collected from five locations along the Snake River. One of 12 samples had measurable gross alpha activity. Nine of 12 samples had measurable gross beta activity, while only one sample had measurable tritium. None of these constituents were above regulatory limits. Onsite sampling of surface water runoff for waste management purposes showed no values above regulatory limits.

Table ES-2 summarizes the results of radiological monitoring of environmental media, including water, collected at INEEL boundary, onsite, and offsite locations.

Environmental Monitoring Programs - Agricultural Products, Wildlife, Soil, and Direct Radiation (Chapter 7)

To help assess the impact of contaminants released to the environment by operations at the INEEL, agricultural products (milk, lettuce, wheat, potatoes, and sheep); wildlife; and soil were sampled and analyzed for radionuclides. In addition, direct radiation was measured on and off the INEEL in 2003.

Some human-made radionuclides were detected in agricultural product, wildlife, and soil samples. For the most part, the results could not be directly linked to operations at the INEEL.

Direct radiation measurements made at offsite, boundary and onsite locations (except RWMC) were consistent with background levels.

Table ES-2 summarizes the results of radiological monitoring of environmental media, including biota and soil, collected at INEEL boundary and offsite locations.

Dose to the Public and Biota (Chapter 8)

Potential radiological doses to the public from INEEL operations were evaluated to determine compliance with pertinent regulations and limits. Two different computer programs were used to estimate doses: the CAP-88 computer code and the mesoscale diffusion (MDIFF) air dispersion model. CAP-88 is required by the EPA to demonstrate compliance with the Clean Air Act. The National Oceanic and Atmospheric Administration Air Resources Laboratory-Field Research Division developed MDIFF to evaluate dispersion of pollutants in arid environments such as those found at the INEEL. The maximum calculated dose to an individual by either of the methods was well below the applicable radiation protection standard of 10 mrem/yr. The dose to the maximally exposed individual, as determined by the CAP-88, program was 0.035 mrem (0.35 μSv). The dose calculated by the MDIFF program was 0.024 mrem (0.24 μSv). The maximum potential population dose to the approximately 276,979 people residing within an 80-km (50-mi) radius of any INEEL facility was 0.022 person-rem, well below that expected from exposure to background radiation.

Potential doses to members of the public are summarized in Table ES-3.

The maximum potential individual doses from consuming waterfowl, big game animals, and marmots at the INEEL, based on the highest concentrations of radionuclides measured in samples of these animals, were estimated to be 0.002 mrem (0.02 μSv), 0.045 mrem (0.45 μSv), and 0.006 mrem (0.06 μSv), respectively. These estimates are conservatively high.

Doses were also evaluated using a graded approach for nonhuman biota at the INEEL. Based on this approach, there is no evidence that INEEL-related radioactivity in soil or water is harming populations of plants or animals.

Table ES-3. Summary of annual effective dose equivalents due to INEEL operations (2003).

	Maximum Dose to an Individual[a]		Population Dose
	CAP-88[b]	MDIFF[c]	MDIFF
Dose	0.035 mrem (3.5×10^{-4} mSv)	0.024 mrem (2.4×10^{-4} mSv)	0.022person-rem (2.2×10^{-4} person-Sv)
Location	Frenchman's Cabin	Frenchman's Cabin	Area within 80 km (50 mi) of any INEEL facility
Applicable radiation protection standard[d]	10 mrem (0.1 mSv)	10 mrem (0.1 mSv)	No standard
Percentage of standard	0.35 percent	0.24 percent	No standard
Natural background	363 mrem (3.6 mSv)	363 mrem (3.6 mSv)	100,540 person-rem (1,005 person Sv)
Percentage of background	0.01 percent	0.007 percent	0.00002 percent

a. Hypothetical dose to the maximally exposed individual residing near the INEEL.

b. Effective dose equivalent calculated using the CAP-88 code.

c. Effective dose equivalent calculated using the MDIFF air dispersion model. MDIFF calculations do not consider occupancy time or shielding by buildings.

d. Although the DOE standard for all exposure models is 100 mrem/yr as given in DOE Order 5400.5, DOE guidance states that DOE facilities will comply with the EPA standard for the airborne pathway of 10 mrem/yr.

Ecological Research at the Idaho National Environmental Research Park (Chapter 9)

The INEEL was designated as a National Environmental Research Park (NERP) in 1975. The NERP program was established in the 1970s in response to recommendations from citizens, scientists, and members of Congress to set aside land for ecosystem preservation and study. In many cases, these protected lands became the last remaining refuges of what were once extensive natural ecosystems. The NERPs provide rich environments to train researchers and introduce the public to ecological science. They have been used to educate grade school and high school students and the general public about ecosystem interactions at DOE sites; to train graduate and undergraduate students in research related to site-specific, regional, national, and global issues; and promote collaboration and coordination among local, regional, and national public organizations, schools, universities, and federal and state agencies.

Ecological research at the INEEL began in 1950 with the establishment of the long-term vegetation transect. This is perhaps DOE's oldest ecological data set and one of the oldest vegetation data sets in the West. Ecological research on the NERPs is leading to planning for better land use, identifying of sensitive areas on DOE sites so that restoration and other activities are compatible with ecosystem protection and management, and increasing contributions to ecological science in general.

The following ecological research projects took place at the Idaho NERP during 2003:

- Monitoring Amphibian and Reptile Populations on the INEEL;
- The Affect of Landscape Change on the Life History of Western Rattlesnakes;
- Factors that Influence the Road Mortality of Snakes on the Eastern Snake River Plain;
- Behavior, Dispersal, and Survival of Captive-Raised Idaho Pygmy Rabbits Released onto the INEEL in Idaho;
- Use of Genetic Markers as a Screening Tool for Ecological Risk Assessment at the INEEL: Microsatellite Mutation Rate of Burrowing Mammals;
- Crested Wheatgrass Rates of Spread into Native Sagebrush Steppe in Eastern Idaho;
- Experimental Remote Sensing of Vegetation on the INEEL;
- Natural and Assisted Recovery of Sagebrush in Idaho's Big Desert;
- Sagebrush Demography;
- Development of an Intregrated Watershed Information Tool for Long-term Facilities, Stewardship at the INEEL;
- Ecological Impacts of Irrigating Native Vegetation with Treated Sewage Wastewater;
- The Protective Cap/Biobarrier Experiment;
- Assessing the Effects of Soil-forming Processes on Surface Caps; and
- Coupled Effects of Biointrusion and Precipitation on Soil Caps.

Quality Assurance (Chapter 10)

Quality assurance and quality control programs are maintained by contractors conducting environmental monitoring and by laboratories performing environmental analyses to ensure precise, accurate, representative, and reliable results and maximize data completeness. Data reported in this document were obtained from several commercial, university, government, and government contractor laboratories. To assure quality results, these laboratories participate in a number of laboratory quality check programs.

Laboratories used by the ESER contractor met their quality assurance goals in 2003. Quality issues that arose with laboratories used by the M&O contractor were addressed with the laboratory and resolved.

Helpful Information

C. Martin and M. Case - S. M. Stoller Corporation

Scientific Notation

Scientific notation is used to express numbers that are very small or very large. A very small number is expressed with a negative exponent, for example, 1.3 x 10^{-6}. To convert this number to the decimal form, the decimal point must be moved left by the number of places equal to the exponent (six, in this case). The number, thus, becomes 0.0000013.

For large numbers, those with a positive exponent, the decimal point is moved to the right by the number of places equal to the exponent. The number 1,000,000 can be written as 1.0 x 10^{6}.

Unit Prefixes

Units for very small and very large numbers are often expressed with a prefix. One common example is the prefix kilo (abbreviated k), which means 1000 of a given unit. One kilometer is, therefore, equal to 1000 meters. Table P-1 shows fractions and multiples of units while, Table P-2 provides useful conversions.

Table P-1. Fractions and Multiples of Units

Multiple	Decimal Equivalent	Prefix	Symbol
10^{6}	1,000,000	mega-	M
10^{3}	1,000	kilo-	k
10^{2}	100	hector-	h
10	10	deka-	da
10^{-1}	0.1	deci-	d
10^{-2}	0.01	centi-	c
10^{-3}	0.001	milli-	m
10^{-6}	0.000001	micro-	µ
10^{-9}	0.000000001	nano-	n
10^{-12}	0.000000000001	pico-	p
10^{-15}	0.000000000000001	femto-	f
10^{-18}	0.000000000000000001	atto-	a

Units of Radioactivity, Radiation Exposure, and Dose

The basic unit of radioactivity used in this report is the curie (abbreviated Ci). The curie is historically based on the number of disintegrations that occur in 1 gram of the radionuclide radium-226, which is 37 billion nuclear disintegrations per second. For any other radionuclide, 1 Ci is the amount of the radionuclide that decays at this same rate.

Radiation exposure is expressed in terms of the roentgen (R), the amount of ionization produced by gamma radiation in air. Dose is given in units of roentgen equivalent man (or rem), which takes into account the effect of radiation on tissues. For the types of environmental radiation generally encountered, the unit of roentgen is approximately numerically equal to the unit of rem. A person-rem is the sum of the doses received by all individuals in a population.

The concentration of radioactivity in air samples is expressed in units of microcuries per milliliter (µCi/mL) of air. For liquid samples, such as water and milk, the units are in picocuries per liter (pCi/L). Radioactivity in agricultural products is expressed in nanocuries per gram (nCi/g) dry weight. Annual human radiation exposure, measured by environmental dosimeters, is expressed in units of milliroentgens (mR). This is sometimes expressed in terms of dose as millirem (mrem), after being multiplied by an appropriate dose equivalent conversion factor.

The Système International is also used to express units of radioactivity and radiation dose. The basic unit of radioactivity is the Becquerel (Bq), which is equivalent to 1 nuclear disintegration per second. The number of curies must be multiplied by 3.7×10^{10} to obtain the equivalent number of Becquerels. Radiation dose may also be expressed using the Système International unit sievert (Sv), where 1 Sv equals 100 rem. Table P-2 provides conversions from conventional to Système International units.

Uncertainty of Measurements

There is always an uncertainty associated with the measurement of environmental contaminants. For radioactivity, a major source of uncertainty is the inherent statistical nature of radioactive decay events, particularly at the low activity levels encountered in environmental samples. The uncertainty of a measurement is denoted by following each result with plus or minus (±) the estimated sample standard deviation, s, that is obtained by propagating sources of analytical uncertainty in measurements. Analytical uncertainties are reported as 1s in this report, unless noted otherwise, for consistency with other INEEL environmental monitoring reports.

Negative Numbers as Results

Negative values occur in radiation measurements when the measured result is less than a pre-established average background level for the particular counting system and procedure used. These values are reported as negative, rather than as "not detected" or "zero," to better enable statistical analyses and observe trends or bias in the data.

Table P-2. Conversion Table

Multiply	By	To Obtain	Multiply	By	To Obtain
in.	2.54	cm	cm	0.394	in.
ft	0.305	m	m	3.28	ft
mi	1.61	km	km	0.621	mi
lb	0.4536	kg	kg	2.205	lb
liquid qt-U.S.	0.946	L	L	1.057	liquid qt-U.S.
ft^2	0.093	m^2	m^2	10.764	ft^2
mi^2	2.59	km^2	km^2	0.386	mi^2
ft^3	0.028	m^3	m^3	35.31	ft^3
d/m	0.450	pCi	pCi	2.22	d/m
pCi	10^{-6}	µCi	µCi	10^{6}	pCi
pCi/L (water)	10^{-9}	µCi/mL (water)	µCi/mL (water)	10^{9}	pCi/L (water)
pCi/m^3 (air)	10^{-12}	µCi/mL (air)	µCi/mL (air)	10^{12}	pCi/m^3 (air)
Curie (Ci)	3.7×10^{10}	Becquerel (Bq)	Becquerel (Bq)	27×10^{-12}	Curie (Ci)
Rad (radiation absorbed dose)	0.01	Gray (Gy)	Gray (Gy)	100	Rad (radiation absorbed dose)
Rem (Roentgen equivalent man)	0.001	Sievert (Sv)	Sievert (Sv)	100	Rem (Roentgen equivalent man)
mrem	10	µSv	µSv	0.1	mrem

Radionuclide Nomenclature

Radionuclides are frequently expressed with the one- or two-letter chemical symbol for the element. Radionuclides may have many different isotopes, which are shown by a superscript to the left of the symbol. This number is the atomic weight of the isotope (the number of protons and neutrons in the nucleus of the atom). Radionuclide symbols used in this report are shown in Table P-3.

Table P-3. Radionuclides and symbols used in this report.

Radionuclide	Symbol	Radionuclide	Symbol
Actinium-228	^{228}Ac	Neptunium-237	^{237}Np
Americium-241	^{241}Am	Neptunium-239	^{239}Np
Americium-243	^{243}Am	Nickel-59	^{59}Ni
Antimony-124	^{124}Sb	Nickel-63	^{63}Ni
Antimony-125	^{125}Sb	Niobium-94	^{94}Nb
Antimony-127	^{127}Sb	Niobium-95	^{95}Nb
Argon-41	^{41}Ar	Potassium-40	^{40}K
Barium-133	^{133}Ba	Plutonium-238	^{238}Pu
Barium-137	^{137m}Ba	Plutonium-239	^{239}Pu
Barium-139	^{139}Ba	Plutonium-239/240	$^{239/240}$Pu
Barium-140	^{140}Ba	Plutonium-240	^{240}Pu
Barium-141	^{141}Ba	Plutonium-241	^{241}Pu
Beryllium-7	^{7}Be	Plutonium-242	^{242}Pu
Bismuth-214	^{214}Bi	Praseodymium-144	^{144}Pr
Carbon-14	^{14}C	Promethium-147	^{147}Pm
Cesium-134	^{134}Cs	Radium-226	^{226}Ra
Cesium-137	^{137}Cs	Radium-228	^{228}Ra
Cesium-138	^{138}Cs	Rubidium-88	^{88}Rb
Chromium-51	^{51}Cr	Rubidium-88d	^{88d}Rb
Cobalt-58	^{58}Co	Rubidium-89	^{89}Rb
Cobalt-60	^{60}Co	Ruthenium-103	^{103}Ru
Curium-141	^{141}Cm	Ruthenium-106	^{106}Ru
Curium-144	^{144}Cm	Samarium-151	^{151}Sm
Curium-242	^{242}Cm	Scandium-46	^{46}Sc
Curium-244	^{244}Cm	Silver-110m	^{110m}Ag
Europium-152	^{152}Eu	Sodium-24	^{24}Na
Europium-154	^{154}Eu	Strontium-89	^{89}Sr
Hafnium-181	^{181}Hf	Strontium-90	^{90}Sr
Tritium	^{3}H	Technetium-99m	^{99m}Tc
Iodine-125	^{125}I	Technetium-99	^{99}Tc
Iodine-129	^{129}I	Tellurium-125m	^{125m}Te
Iodine-131	^{131}I	Thorium-232	^{232}Th
Iodine-132	^{132}I	Thorium-230	^{230}Th
Iodine-133	^{133}I	Thorium-228	^{228}Th
Iodine-134	^{134}I	Tungsten-187	^{187}W
Iodine-135	^{135}I	Uranium-232	^{232}U
Iridium-192	^{192}I	Uranium-233	^{233}U
Iron-55	^{55}Fe	Uranium-233/234	$^{233/234}$U
Iron-59	^{59}Fe	Uranium-234	^{234}U
Krypton-85	^{85}Kr	Uranium-235	^{235}U
Krypton-85m	^{85m}Kr	Uranium-235/236	$^{235/236}$U
Krypton-87	^{87}Kr	Uranium-238	^{238}U
Krypton-88	^{88}Kr	Xenon-133	^{133}Xe
Lanthanum-140	^{140}La	Xenon-135m	^{135}Xe
Lead-212	^{212}Pb	Xenon-138	^{138}Xe
Lead-214	^{214}Pb	Yttrium-90	^{90}Y
Manganese-54	^{54}Mn	Yttrium-91	^{91}Y
Mercury-203	^{203}Hg	Zinc-65	^{65}Z
Molybdenum-99	^{99}Mo	Zirconium-95	^{95}Zr

a. The letter ‘m’ after a number denotes a metastable (transitional isotope normally with very short half=lives) isotope.

Acronyms

AAO	Argonne Area Office (DOE-CH)
AEC	U.S. Atomic Energy Commission
ALSM	Airborn Laser Swath Mapping
ANL-W	Argonne National Laboratory-West
ANOVA	Analysis of Variance
ARA	Auxiliary Reactor Area
ASME	American Society of Mechanical Engineers
BBI	Bechtel Bettis, Inc.
BBS	Breeding Bird Survey
BBWI	Bechtel BWXT Idaho, LLC
BCG	Biota Concentration Guides
BDN	Bayesian Decision Network
BLM	U.S. Bureau of Land Management
BLR	Big Lost River
BNFL	British Nuclear Fuels Limited
BOD	Biological Oxygen Demand
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERT	Controlled Environmental Radioiodine Test
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CITR	Critical Infrastructure Test Range
CMS	Community Monitoring Station

COD	Chemical Oxygen Demand
CTF	Contained Test Facility
CWA	Clean Water Act
DCG	Derived Concentration Guide
DEM	Digital Elevation Model
DEQ	(Idaho) Department of Environmental Quality
DOE	U.S. Department of Energy
DOE-CH	U.S. Department of Energy - Chicago Operations Office
DOE-ID	U.S. Department of Energy - Idaho Operations Office
EA	Environmental Assessment
EAL	Environmental Assessment Laboratory
EBR-I	Experimental Breeder Reactor - No. 1
EBTF	Engineered Barrier Test Facility
ECF	Expended Core Facility
EDF	Experimental Dairy Farm
EFS	Experimental Field Station
EIS	Environmental Impact Statement
EM	Environmental Management
EML	Environmental Measurements Laboratory
EMS	Environmental Management System
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESER	Environmental Surveillance, Education and Research
ESRF	Environmental Science and Research Foundation
ESRPA	Eastern Snake River Plain Aquifer
ESRP	Eastern Snake River Plain

ET	Evapotranspiration
FFA/CO	Federal Facility Agreement and Consent Order
GEL	General Engineering Laboratories
GIS	Geographic Information System
GPS	Global Positioning System
HDR	Hydrogeological Data Repository
HDS	Head Dissipation Sensors
ICP/AES	Inductively Coupled Plasma/Atomic Emission Spectroscopy
ICPP	Idaho Chemical Processing Plant
IDAPA	Idaho Administrative Procedures Act
IMPROVE	Interagency Monitoring of Protected Visual Environments
IMU	Inertia Mesurements Unit
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center (formerly Idaho Chemical Processing Plant)
IRC	INEEL Research Center
ISB	In Situ Bioremediation
ISFSI	Independent Spent Fuel Storage Installation
ISO	International Standards Organization
ISU	Idaho State University
IWIMT	Integrated Watershed Information Management Tools
LDRD	Laboratory Directed Research and Development
LFR	Live Fire Range
LTS	Long-Term Stewardship
M&O	Management and Operating
MCL	Maximum Contaminant Level

MDC	Minimum Detectable Concentration
MDIFF	Mesoscale Diffusion Model
MEI	Maximally Exposed Individual
MNA	Monitored Natural Attenuation
MTR	Materials Test Reactor
NEPA	National Environmental Policy Act
NERP	National Environmental Research Park
NESHAP	National Emission Standards for Hazardous Air Pollutants
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NOAA ARL-FRD	National Oceanic and Atmospheric Administration Air Resources Laboratory - Field Research Division
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NPTF	New Pump and Treatment Facility
NRC	U.S. Nuclear Regulatory Commission
NRF	Naval Reactors Facility
NRTS	National Reactor Testing Station
NWQL	National Water Quality Laboratory (USGS)
OU	Operable Unit
PBF	Power Burst Facility
PCB	Polychlorinated Biphenyls
PCBE	Protective Cap/Biobarrier Experiment
PCS	Primary Constituent Standard
PSD	Prevention of Significant Deterioration
PTC	Permit to Construct

QA	Quality Assurance
RCRA	Resource Conservation and Recovery Act
RE	Removal Efficiencies
RESL	Radiological and Environmental Sciences Laboratory
RI/FS	Remedial Investigation/ Feasibility Study
RML	Radiological Measurements Laboratory (INEEL)
RPD	Relative Percent Difference
ROD	Record of Decision
RWMC	Radioactive Waste Management Complex
SAM	Sample and Analysis Management
SCS	Secondary Constituent Standard
SD	System Dynamics
SDA	Subsurface Disposal Area
SMC	Specific Manufacturing Capability
SRPA	Snake River Plain Aquifer
STL	Severn Trent Laboratories
TAN	Test Area North
TCE	Trichloroethylene
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TLD	Thermoluminescent Dosimeter
TRA	Test Reactor Area
TRU	Transuranic (waste)
TSA	Transuranic Storage Area
TSCA	Toxic Substances Control Act
TSF	Technical Support Facility

TSS	Total Suspended Solids
USFWS	U.S. Fish and Wildlife Services
USGS	U.S. Geological Survey
WAG	Waste Area Group
WERF	Waste Experimental Reduction Facility
WLAP	Wastewater Land Application Permit
WSU	Washington State University

Units

Btu	British thermal unit
Bq	becquerel
cfm	cubic feet per minute
Ci	curie
cm	centimeter
cpm	counts per minute
d	day
dl	detection limit
dpm	disintegrations per minute
ft	feet
g	gram
gal	gallon
gpd	gallons per day
ha	hectare
hr	hour
in.	inch
KeV	kilo-electron-volts
kg	kilogram
km	kilometer
L	liter
lb	pound
m	meter
mi	mile
min	minute
mL	milliliter
µCi	microcurie (10^{-6} curies)
µg	microgram
µm	micrometer
µS	microsiemens
mmhos/cm	millimhos per centimeter
mph	miles per hour
mR	milliroentgen
mrem	millirem
mSv	millisievert
ng	nanogram
nm	nanometer
oz	ounce
pCi	picocurie (10^{-12} curies)
ppb	parts per billion
qt	quart
rem	roentgen equivalent man
R	roentgen
sec	second
Sv	seivert
x^2	unit squared
x^3	unit cubed
yd	yard
yr	year
$<$	lesser than
$>$	greater than